"Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm." By J. B. FARMER, M.A., and A. D. WALLER, M.D., F.R.S. Received March 9,—Read May 5, 1898.

The object in view was to observe simultaneously and comparatively the effects of certain anæsthetics (carbon dioxide, ether, and chloroform) upon vegetable and upon animal protoplasm.

Two gas chambers in series, through which anæsthetic and other vapours can be passed, contain: the first, a leaf of *Elodea Canadensis* under the microscope (× 300); the second, a sciatic nerve of *Rana temporaria* connected with an inductorium and galvanometer (or upon occasion a galvanograph).*

The actual movements of chlorophyll bodies in a cell of the leaf were observed and measured by one of us, while the other observer took readings of the galvanometric deflections in response to excitation of the nerve. To establish comparison between the two classes of effects, we took as measures:—the number of chlorophyll bodies that crossed a cobweb in the eye-piece during each successive minute, and the magnitude of galvanometric deflections at intervals of one minute, before, during, and after the action of the vapour. The number of bodies passing per minute gives measure of the rate of movement in the vegetable protoplasm, while the magnitude of successive galvanometric deflections gives measure of the mobility of the animal protoplasm.

Our results will be most briefly presented by the records of some representative observations.

Experiment I.

	Chara.	*Nerve.*
Chloroform vapour, 5 per cent. for 2 minutes.	Permanent abolition of movement.	Temporary abolition of mobility.

Experiment II.

Weak ether vapour for 10 minutes.	No marked effect.	No marked effect.
Stronger ether vapour for 4 minutes.	Permanent abolition.	Temporary diminution.

* As described in 'Phil. Trans.,' B, vol. 188 (1897), p. 4.

Experiment III.

	Elodea.	*Nerve.*
Nitrous oxide for 5 minutes.	Diminution of movement.	Diminution of responses.
Hydrogen for 5 minutes.	Diminution.	Diminution.
Carbon dioxide for 3 minutes.	Arrested, followed by more rapid movement.	Diminution from 15 to 5, followed by augmentation to 35.
Carbon dioxide for 4 minutes.	Ditto.	Diminution, followed by augmentation.
Carbon dioxide for 2 minutes.	Ditto.	Ditto.

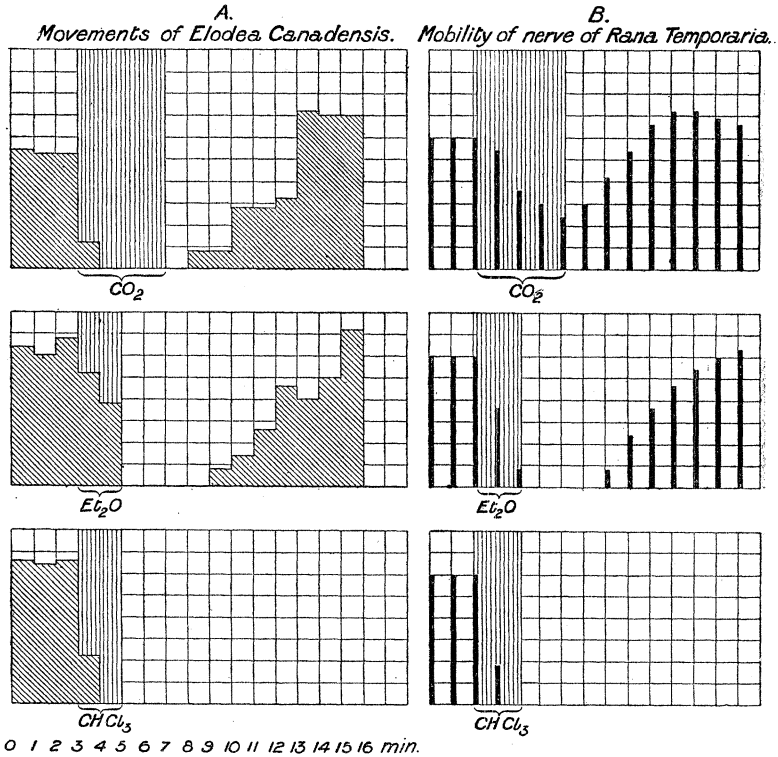
Experiment IV.

Elodea.

Time.	Rate of movement, indicated by number of chlorophyll granules passing per minute.	Time.	Rate of movement, indicated by number of chlorophyll granules passing per minute.
1	18	19	12
2	15	20	20
CO_2 3	4	21	26
CO_2 4	0	22	26
5	0	23	26
6	0	24	26
7	6	CO_2 25	6
8	6	CO_2 26	0
9	6	CO_2 27	0
10	16	CO_2 28	0
11	26	29	0
12	17	30	4
13	15	31	4
CO_2 14	19	32	14
CO_2 15	0	33	16
16	13	34	36
17	1	35	35
18	0		

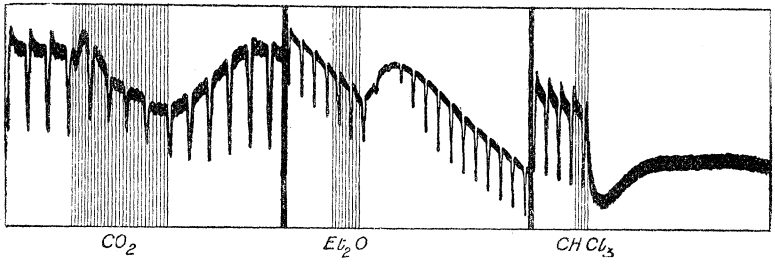
Experiments V, VI, and VII.

Action of Carbon Dioxide, of Ether, and of Chloroform upon Vegetable and Animal Protoplasm.



The results obtained from a study of *Chara* and *Elodea* were quite consistent, but owing to the greater ease in making a quantitative determination, the latter plant was used for the more exact comparative experiments.

The action of carbon dioxide was to produce an initial slight acceleration, followed speedily by a complete cessation of movement. After disconnecting the CO_2 apparatus and aspirating air through the chamber the protoplasm, after the lapse of two or three minutes, began to show signs of recovery. Fitful movements of the granules first occurred, and then they soon resumed their processional motion around the cell. At first very slow, the movement rapidly became accelerated and considerably exceeded the normal rate. This acceleration was not of long duration, and was followed by a slowing down to the ordinary speed.



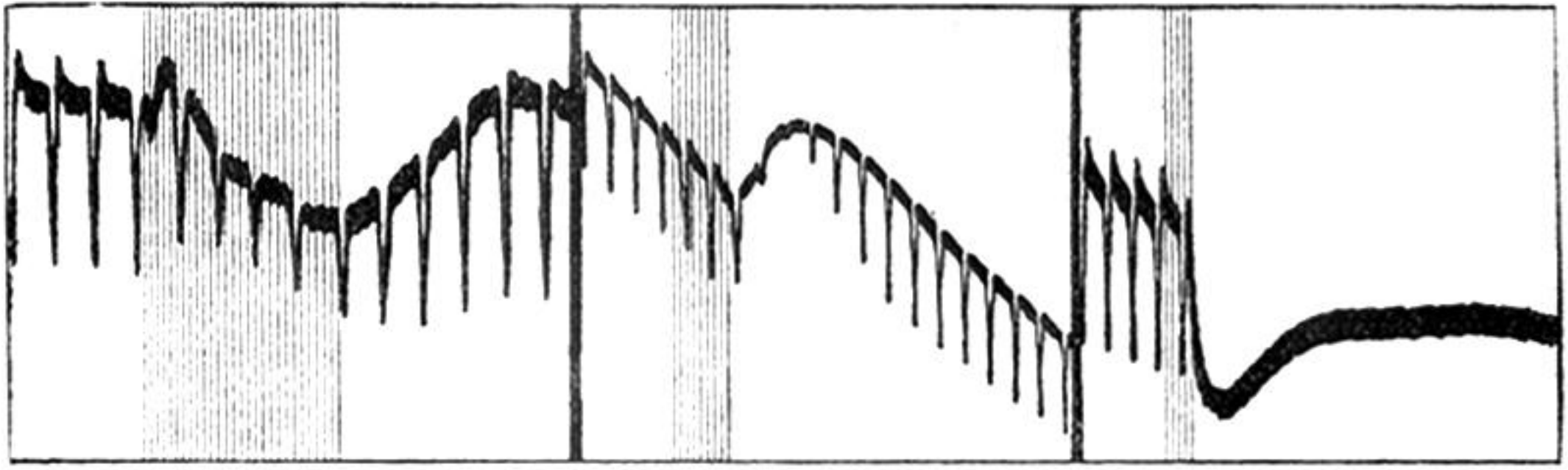
The nerve showed itself, under the conditions of the experiment, less sensitive to the action of CO_2 than was *Elodea*, and the latter was less sensitive than an active Myxomycete plasmodium (of *Badhamia*) similarly treated.

Ether vapour in air passed over the plant for two minutes caused a speedy arrest of all movement, and the quiescent condition persisted for some minutes longer. Recovery then ensued and the normal rate of movement was slowly regained. With dilute ether vapour (below 10 per cent. in air) insufficient to anæsthetise the nerve, the protoplasmic circulation was unaffected.

Chloroform.—The action of chloroform proved to be far more deadly than that of ether. Movement was arrested in less than a minute, and two minutes' exposure to the full action of its vapour caused the death of the cell.

When a more diluted vapour (about 2 per cent. in air) was passed over the cell for two minutes recovery ultimately occurred.

The action of ether and chloroform, especially the latter, was very marked in causing many of the chlorophyll granules, which had previously been almost restricted to the lateral walls, and hence had presented their edges to the incident light, to become dispersed over the surface of the cell, where they were fully exposed, over their largest area to the light. The action of carbon dioxide as observed in these experiments was not nearly so pronounced. This phenomenon is such as might have been anticipated as a result of the paralysis, temporary or permanent, of the protoplasm.


CO_2
Et_2O
$CHCl_3$